

On the Expression of M. Delaunay's $h + g$ in terms of his finally adopted Constants. By Prof. Cayley.

I had the pleasure of receiving from M. Delaunay a letter dated Paris, 17th Dec. 1871, in which he informs me that, on referring to his papers, he had found there expressions for l, g, h , identical with those given by me in the November Number of the *Monthly Notices*,—with only a single typographical error, $\frac{23}{33} e'^2 m^3$ instead of $\frac{23}{32} e'^2 m^3$ in my expression of h .

M. Delaunay mentions also that he had obtained four additional terms in the expression for $h + g$ (longitude of the Moon's perigee), and that the complete expression in terms of the finally adopted constants is—

$h + g =$

$$\begin{aligned}
 nt \left\{ \left(\frac{3}{4} - 6\gamma^2 - \frac{3}{8}e^2 + \frac{9}{8}e'^2 - \frac{45}{4}\gamma^4 + \frac{69}{8}\gamma^2e^2 - 9\gamma^2e'^2 - \frac{3}{32}e^4 - \frac{9}{16}e^2e'^2 + \frac{45}{32}e'^4 \right) m^2 \right. \\
 + \left(\frac{225}{32} - \frac{189}{8}\gamma^2 - \frac{675}{64}e^2 + \frac{825}{32}e'^2 + \frac{1107}{16}\gamma^4 + \frac{81}{32}\gamma^2e^2 - \frac{349}{4}\gamma^2e'^2 - \frac{2475}{64}e^2e'^2 \right) m^3 \\
 + \left(\frac{4071}{128} - \frac{3963}{32}\gamma^2 - \frac{31605}{512}e^2 + \frac{61179}{256}e'^2 \right) m^4 \\
 + \left(\frac{265493}{2048} - \frac{335403}{512}\gamma^2 - \frac{1483665}{4096}e^2 + \frac{1767849}{1024}e'^2 \right) m^5 \\
 + \left(\frac{12822631}{24576} - \frac{25291729}{16384}e^2 \right) m^6 \\
 + \left(\frac{1273925965}{589824} + \frac{352038855}{1179648}e^2 \right) m^7 \\
 + \frac{71028685589}{7077888} m^8 \\
 + \frac{32145914707741}{679477248} m^9 \\
 \left. + \left[\frac{45}{32} m^2 + \frac{7425}{512} m^3 \right] \frac{a^2}{a'^2} \right\}
 \end{aligned}$$

On the Zodiacal Light. By Captain Tupman.

During a stay of some three years in the Mediterranean I had many opportunities of observing the Zodiacal Light. Occasionally, but very seldom, it was so bright and its boundaries so well defined, it was easy to trace the latter on a star-chart with considerable accuracy.

From the beginning these observations appeared to me to

present features of great interest, and I endeavoured to continue them on every favourable opportunity, especially in the early mornings when the eye-sight is most sensitive. After December, 1870, no such opportunity occurred, the planets *Venus* and *Jupiter* remaining for months in the middle of it, just when the ecliptic was most favourably elevated above the horizon.

The variation of its light is very remarkable. Sometimes it attains a brilliancy that is not sensibly affected by the brighter planets shining in the midst of it, and after an interval of a few days its light may be quite faint.

Its apparent angular extension from the Sun doubtless depends upon the keenness of the observer's sight, the clearness of the atmosphere, and the general inclination of its axis of symmetry to the horizon. An illustrious Continental astronomer once assured me that he frequently saw it completing the circle of the heavens, with a small cloud-like maximum of brilliancy opposite the Sun; and there are the well-known observations of M. Liais in corroboration.

The sight of a particular observer, however, may be considered **constant**, and, hence, great actual variations of the intensity of the light, **not only** near the Sun, but in every part of its zone, must be admitted.

Another, and perhaps more singular, feature is the variable position of the apparent axis of symmetry with regard to the plane of the ecliptic. It is true that this element cannot be determined with accuracy, but there are times when an error of 3 or 4 degrees is inadmissible. Such times have been chosen for making the sketches I now send, which show, not only an inclination of the axis to the ecliptic, amounting, in the months of August and September, to 20° , but also that *its plane does not pass through the Sun*. Six of the morning observations agree in placing the eastern node 40° behind the Sun, and the only evening observation places the western node 42° before the Sun; in the former the axis crossing from North to South, in the latter from South to North. The observation on the morning of the 7th of January, 1870, places the axis parallel to and 3° North of the ecliptic, and on that occasion an error of 3° in its absolute position was highly improbable, as 3° of azimuth on the horizon appears to cover a large space.

The effect of refraction in raising the lower part of the more inclined border more than the upper part is quite inappreciable.

It would be exceedingly interesting to compare observations of this nature made, simultaneously or nearly so, at considerable distances on either side of the equator.

In conclusion, I have only to remark that the drawings were made on charts containing the stars only; the ecliptic was then added and the whole traced off. I send the original tracings.*

* These tracings were exhibited at the November Meeting, and are preserved for inspection in the Library of the Society.

Details of the Observations.

Place,	Day (Astron), 1866,	h Time before Sunrise.	Inclination of Axis of Symmetry to the Elliptic.	Distance of Node of Axis from the Sun.	Distance of Apex from the Sun, in Longitude.	Latitude of Apex.	Curvature of N. and S. Borders and general Angle between them.	Intensity of the Zodiacal Light.	State of the Atmosphere.	No. of Sketch	Notes.
Lisbon	Sept. 13	2 50	20°	42°	61°	-6°	Convex, 48°	v. v. bright	v. clear	1	The light fading off gradually at the borders. Axis almost coinciding with the parallel +18°.
"	"	1 50	20°	42°	51°	-4°	Convex, 38°	v. v. bright	v. clear	2	
"	Sept. 14	2 50	20°	42°	61°	-6°	Convex, 48°	v. v. bright	v. clear	1	The sketches of yesterday exactly suit the appearances to-day.
"	"	1 50	20°	42°	51°	-4°	Convex, 38°	v. v. bright	v. clear	1	
Cadiz	Sept. 15	2 0	20°?	—	60°?	—	Convex	v. bright	v. clear	—	Appearance the same as on two previous days.
Gibraltar	Oct. 4	2 0	0°	—	66°	+2°	straight, 35°	bright	v. v. clear	3	Axis certainly not inclined 3°. An hour earlier the apex was observed in the same place, but the cone was narrower.
"	Oct. 8	2 10	5°	56±8	69°	+2°	straight, 34°	bright	v. clear	4	Borders sharply defined (comparatively).
Malta	Oct. 11	4 0 to 3 0	0°	—	81°	+2°	straight, or slightly con- cave, 43°	v. v. bright	v. clear	5	The apex stationary among the stars for more than two hours, and more sharply defined than usual. Axis sensibly coinciding with ecliptic.
"	Oct. 14	3 0 to	0°	—	84°	—	—	bright	v. clear	—	Apex beyond the Praesepe in Cancer, but after the brighter portion rose, it could

"	Nov. 3	1 30	0	—	69	—	well defined	display faint	v. clear	7	The light faint, although the air very clear.
"	Nov. 11	2 20	0	—	77	—	—	bright	v. clear	—	Apex extending nearly to <i>Regulus</i> .
Malta	1872. Jan. 7	3 10 to 2 10	0	—	113	+2	very concave	bright	v. clear	8	Axis parallel to, but 3° N of ecliptic. At times the apex seen extending to β <i>Ving</i> . Base broad.
Vigo	Aug. 31	2 0	23	U 40	58	-6	Convex, 43°	bright	v. v. clear	9	The borders, if prolonged a little, would intersect at γ <i>Geminorum</i> .
"	Sept. 5	1 40	16	U 40	73	-7	slightly concave, 20°	exceedingly bright	v. v. clear	10	The light exceedingly bright between <i>Venus</i> and <i>Mars</i> , both planets being within its cone.
Malta	Dec. 14	2 15 after sunset	7	U 42	160 to 170	—	slightly concave	bright	v. clear	11	<i>Evening</i> . Easily traced nearly to <i>Pleiades</i> , and at times 10°-20° beyond.
"	1871. April 29	2 0 before sunrise	—	—	—	—	—	—	—	—	No trace of it, although the ecliptic most favourably situated.
"	May 7	1 40 after sunset	—	—	80	—	—	v. bright	v. clear	—	<i>Venus</i> and <i>Jupiter</i> both shining brightly in it. Axis about perpendicular to the horizon. Apex is in north latitude.
"	May 8	2 ^h to 3 ^h after sunset	—	—	100	+4	—	faint	clear	—	Much diffused. After <i>Venus</i> and <i>Jupiter</i> had set, seen extending to α and γ <i>Leonis</i> .
"	May 14	1 ^h 50 ^m after sunset.	—	—	93	+4	—	bright	clear	—	Extending to α and γ <i>Leonis</i> . <i>Venus</i> and <i>Jupiter</i> shining brightly in it.